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ABSTRACT

To evaluate the effectiveness of low-frequency amplification, three classrooms were equipped in an experimental design in which the teacher spoke simultaneously through two different amplifying systems, a low-frequency auditory training unit (Suvag I) and a conventional unit (Warren T-2). Thirty preschool deaf children were matched and assigned to either unit. The same type of output transducers were utilized for all the children. Teachers used the Verbo-tonal Method (primarily an auditory program) for habilitation. The low-frequency unit produced a greater acoustic response below 500 Hz. Hearing aids were selected that produced frequency responses similar to the training units (the Mini Suvag for children on the low-frequency unit, the Zenith Vocalizer II for the conventional unit). A Bruel and Kjaer test system was used to evaluate the training units and hearing aids. The Mini Suvag, capable of simultaneously driving a vibrator and a headset, had a greater low-frequency response. (KW)

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A DESIGN TO EVALUATE LOW-FREQUENCY AMPLIFICATION FOR HABILITATING PRESCHOOL DEAF CHILDREN

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ABSTRACT

An experimental design was utilized that permitted a teacher to speak simultaneously through two different amplifying systems, a low-frequency auditory training unit (SUVAG I) and a conventional one (Warren, T-2). The microphones of both units were held securely in one fixture. Preschool deaf children were "matched" and assigned to either unit. The teacher utilized the Verbo-tonal Method for habilitation. Each training unit could independently excite 5 headsets and 5 bone vibrators. The same type of headset and vibrator was utilized for all the children. The electrical response of the low-frequency training unit extended from at least 20 - 20,000 Hz, (± 2 dB) and the response of the conventional unit was 330 - 9,000 Hz. With the same earphone, the acoustic response of both units was similar for high frequencies; however, the low-frequency unit produced a greater response below 500 Hz. Two hearing aids were selected that produced frequency responses that were similar to the training units. The Mini Suvag was assigned to children on the low-frequency unit and the Zenith Vocalizer II was assigned to children on the conventional unit. The Mini Suvag is capable of simultaneously driving a vibrator and a headset, and it can be utilized as a training unit. (Work supported by the Office of Education, U.S. Department of Health, Education and Welfare).

Surveys by Huizing (1959) and Watson (1961) indicated that between 95 and 97% of the children enrolled in schools for the deaf had some measurable hearing, usually below 500 Hz. The results of these surveys are encouraging with respect to the potential of utilizing the low-frequency amplification to improve the speech patterns of deaf children. However, there appears to be a conflict with respect to the "optimum" frequency response for habilitating children. For example, one of the "oldest" manufacturers (Warren) of auditory training units, and probably the most accepted by educators of the deaf, presents this view on frequency response.

> "Although this subject has always been controversial, it is recognized that useful elements of speech communication are between 300 and 3500 Hz. . . For greater intelligibility the frequency response of the Warren T-2 is therefore tailored to these "communication" frequencies. . . We have found through teaching experience in the field that high-frequency squeals and low-frequency room rumble contribute nothing to the voice communication, while they can detract seriously from the training program."

In contrast with this philosophy, Guberina (University of Zagreb, Yugoslavia) who developed the Verbo-tonal Method, indicates that an extended low-frequency response is essential for developing and improving the intonations and rhythmical patterns of speech of the congenitally deaf child. As a result, he has attempted to utilize auditory training units that included an extended low-frequency response.

Investigators such as Ling (1963, 1964) Briskey (1966), and others have examined the effect of utilizing hearing aids with low-frequency responses, and some of these investigators have reported that low-frequency amplification has had positive effects on the vocalizations of deaf children. However, these studies have not included low-frequency auditory training units for training the children to utilize the information in the low frequencies. As a result, the study reported today will include an experimental design that utilizes both auditory training units and hearing aids of different frequency response.

To evaluate the effectiveness of low-frequency amplification, an experimental design was utilized that permitted a teacher to speak simultaneously through two different amplifying systems, a low-frequency auditory training unit (Suvag I) and a conventional unit (Warren T-2). The microphones of both units were held securely in one fixture. The Suvag unit utilized 4 Astatic cartridges (MC-151) wired in paralled and the Warren unit utilized a Shure microphone, Model 777. To minimize problems in the classroom, the same type of output transducers were utilized for all the children. Each training unit could independently excite 5 headsets (Koss, Model SP-3XC) and 5 bone vibrators (Vibra, Model 73). Three classrooms were instrumented with this design. Thirty preschool deaf children were matched and assigned to either unit. All teachers utilized the Verbo-tonal Method (primarily an auditory program), for habilitation. The experimental design attempted to control for differences among teachers.

Two hearing aids were selected that produced frequency responses that were similar to the training units. The Mini-Suvag hearing aid was assigned to the children on the Suvag I unit, and the Zenith Vocalizer II was assigned to the children on the Warren unit. (Slides 1 and 2).

A Bruel and Kjaer test system was utilized to evaluate the training units and the hearing aids. At a minus 3 dB, the electrical response of the Suvag I extended from 70 to 17,000 Hz, and at a -4 dB, it extended the limit of the B & K test system (20-20,000 Hz). Below 20 Hz, the Suvag I unit was evaluated utilizing a low-frequency audio oscillator. The waveform as viewed on an oscilloscope, did not exhibit any visible distortion unitl 2 Hz. At a -3 dB, the electrical response of the Warren unit extended from 400-8,000 Hz. And at a -4 dB, it extended from 330-9,000 Hz. Slides 3 and 4 displays electrical responses of both units. The ordinate axis on all B & K graphs represents a 50 dB range. For each of these evaluations, a 20 millivolt input was utilized.

To evaluate the acoustic response from both units, the same Koss earphone was mounted on a flat-plate coupler. Charan, and others, (JASA 1965) evaluated the effects of utilizing three different flat plate couplers. These included: (1) NBS-9A, (2) ASA Type 1, and (3) the microphone flush with the top surface of the flat plate coupler (no 6 cc cavity). Charan concluded the following: (a) below 2000 Hz, the three couplers were within one dB difference (b) above 2000 Hz, the three couplers differed as much as 14 dB, (c) repeated measures on each coupler did not exceed 1 dB and (d) below 2000 Hz, any of the three couplers are reliable and useful for circumural phones. This information should be kept in mind in any of the responses we view today utilizing a flat plate coupler. (Now let us view slides 5-11). The acoustic response of both units was similar for high frequencies; however, the low-frequency units produced a greater response below 500 Hz. These responses were less than the 10 to 15,000 range indicated on a Koss specification sheet. A frequency response obtained from the Koss electronics is included for comparison.

A Bruel and Kjaer hearing-aid test box was utilized to evaluate both aids. At a -15 dB below the three-frequency average, the frequency range of the Mini-aid was 20 to 4000 Hz and the Zenith was 200 to 4000 Hz. (Slides 12 and 13). For an additional evaluation, each hearing aid was placed in the center of a 8 by 9 foot double-wall, sound treated room (Suttle, Model SE-224). A constant acoustic output of a speaker (Electro-Voice, SP-12) was controlled by the Bruel and Kjaer System and the response of the aids was measured. The frequency response of the hearing aids and the test room is indicated in the next slides. In both of the evaluations, the Mini-Suvag had a greater low-frequency response. (Slide 14-16).

The Mini-Suvag hearing aid, with its auxillary power amplifier, is capable of simultaneously driving a vibrator and a headset, and it can be utilized as a training unit. With such a unit, the parent could be trained to continue the auditory training in the home. (Slide 17 and 18).
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